

Unemployment and Early Cause-Specific Mortality: A Study Based on the Swedish Twin Registry

Margaretha Voss, PhD, MPH, Lotta Nylén, MPH, Birgitta Floderus, PhD, Finn Diderichsen, MD, PhD, and Paul D. Terry, PhD

Loss of a job has pronounced negative effects on an individual's life situation.^{1–10} Several studies have shown an increased risk of early mortality among the unemployed, but the nature of this association is not clear.^{1,2,6–8,11–17} To better understand the relationship between unemployment and mortality, one should consider the meaning of employment beyond earning a living, including the impact on lifestyle, self-image, social integration, and psychological well-being.^{3,18} Unemployment entails an increase in general distress, anxiety, and depression and a decrease in activity,^{4,7,8,17} which in the long run may increase the risk of early death.

The excess risk of mortality associated with unemployment has been attributed mainly to external causes of death, including suicide and undetermined causes^{1,2,4,5,7–9,12,13,16,19,20}; diseases of the circulatory system^{1,21–23}; and lung cancer.^{2,10,12,21,24}

Mortality rates seem to increase with the duration of unemployment^{1,12,17} and are higher for the unemployed than the employed in all social classes.^{6,20} Several studies have suggested that unemployment has a direct effect on health over and above the effects of socioeconomic status, poverty, risk behaviors, or prior ill health.^{1–3,6,16,20,21,25} Unemployment has also been suggested as more important than other socioeconomic variables as a risk factor for premature death.²⁰

It has been suggested that when unemployment rates are low, those with impaired health status are more likely than healthy people to become unemployed.^{1,26,27} In Sweden, unemployment was by all international standards low (2%–4%) between 1950 and 1990 but increased to about 8% during the 1990s.¹⁸

Individuals actively employed may have better health status on average than those outside the workforce because healthy individuals are more likely to enter the workforce. Employees with impaired health or certain risk indicators, such as high alcohol consumption, may also be

more likely to lose their jobs. The effect of unemployment on mortality could therefore also be attributable to confounding from other risk factors.^{11,12,21,24,25,28} In earlier studies, analyses took into account demographic and social characteristics to some extent,^{2,11,16,21,29} while adjustment for potential confounding from other factors was limited.

We have previously shown an increased risk of overall early mortality (i.e., before 70 years of age) among individuals who experienced unemployment.²⁹ The results were similar for women and men, which could reflect that losing or holding a job is equally important among both Swedish men and women. In Denmark, which has a similar labor market, relative risks of about the same magnitude among unemployed men and women were reported.⁹

In our study, we extended the analyses to specific causes of death, accounting for potential confounding from social, behavioral, health, and personality characteristics. We also studied the relation between unemployment and total mortality using pairs of twins, one of whom had experienced employment while the other had not, thus controlling for genetic factors and for social and environmental conditions during childhood and youth. An additional aim was to analyze to what extent the effect of unemployment was modified by the presence of other

Objectives. We investigated the association between unemployment and early cause-specific mortality to determine whether the relationship was modified by other risk indicators.

Methods. Female and male twins (n = 20 632) were followed with regard to mortality from 1973 through 1996. Questionnaire data from 1973 were used to obtain information on experience of unemployment and on social, behavioral, health, and personality characteristics.

Results. Unemployment was associated with an increased risk of suicide and death from undetermined causes. Low education, personality characteristics, use of sleeping pills or tranquilizers, and serious or long-lasting illness tended to strengthen the association between unemployment and early mortality.

Conclusions. An increased risk of death from external causes implies a need for support for those experiencing unemployment, particularly susceptible individuals. (*Am J Public Health.* 2004;94:2155–2161)

risk indicators of early mortality. The study was performed with information from the Swedish twin registry.³⁰

METHODS

Study Population

The study population comprised 18 516 women and 18 020 men, constituting in principle all same-sex twins born in Sweden between 1926 and 1958.³⁰ Data were based on a 1973 mailed questionnaire, which was answered by 15 683 women and 14 287 men (response rate = 85% for women and 79% for men), and on information from the Swedish Causes of Death Registry. All responders with a job title indicating gainful employment were included in the study (i.e., 9500 women and 11 132 men). Housewives, students, retired individuals, persons on disablement pension, and persons liable for military service at baseline were excluded from the analyses.

Unemployment

A short occupational history, including history of unemployment, was recorded in the 1973 questionnaire that included unemployment. Information about unemployment was based on answers to the following questions: "Are you employed at the present time?"; "Are

you now or have you ever been unemployed?"; "For how long have you been unemployed?"

In our main analyses, we compared ever unemployed (875 women and 1309 men) with never unemployed according to the 1973 data. In some analyses, we distinguished between "short-term" and "long-term" unemployment. Short-term unemployment was defined as being unemployed in 1973 and experiencing less than 1 year of lifetime unemployment (144 women and 185 men). Long-term unemployment was defined as being unemployed for 1 year or more altogether during the life course (260 women and 311 men). Small numbers precluded separate analyses of mortality among the short- and long-term unemployed.

Social, Behavioral, Health, and Personality Factors

In the analyses, the following social, behavioral, health, and personality factors were considered: marital status, children, education, smoking and alcohol habits, use of sleeping pills and tranquilizers, stress, shift work, personality factors, long-lasting/serious illness, and socioeconomic status. The selection of potential confounding factors originates from our previous study.²⁹ The variables were dichotomized; "exposed" categories are listed in Table 1 (reference groups were those "not exposed.") The reference category for marital status was married and cohabitant; smokers and former smokers were compared with never smokers. Alcohol consumption was analyzed by consumed grams of absolute alcohol per month.³⁰ No alcohol consumption and consumption of more than 250 g of alcohol per month were compared with consumption of 1 to 250 g of alcohol per month.

"Stressful life" was defined by the question, "Do you experience your everyday life as being very stressful?" The personality factors "instability" and "introversion-extraversion" were based on 9 items each selected from the "neuroticism" and "extraversion" dimensions of the Eysenck personality inventory; these short scales were developed to be used in comprehensive questionnaire investigations.^{31,32} Unstable personality (>4 points) was compared with stable personality (<5 points), and extravert personality (>4 points) with introvert personality (<5 points). The question "Have you ever had any long-term or serious illness?" was used

as an indicator of ill health. Unskilled/skilled workers and low-level white-collar workers were compared with medium- and high-level white-collar workers.

Mortality

All individuals of the study population were followed regarding mortality from January 1, 1973, to December 31, 1996. For deaths that occurred between 1973 and 1986, specific causes of death were taken from the *International Classification of Diseases, Eighth Revision (ICD-8)*³³; for deaths between 1987 and 1996, the *International Classification of Diseases, Ninth Revision (ICD-9)*³⁴ was used. The 2 revisions were then harmonized. The following underlying causes of death were analyzed: malignant neoplasms (ICD-8 codes 140–209); malignant neoplasms of trachea, bronchus, and lung (162); diseases of the circulatory system (390–458); ischemic heart diseases (410–414); injuries, poisoning, and other external causes (E800–E999); suicide (E950–E959); injury, undetermined whether accidentally or purposely inflicted (external undetermined cause; E980–E989); other diseases (001–139, 210–389, 460–799); and alcohol-related diseases (303, 571, 577).

Statistical Analysis

Differences in social, behavioral, health, and personality characteristics between individuals with and without experience of unemployment were analyzed with adjustment for age (5-year intervals), and the statistical precision was indicated by 95% confidence intervals.

We estimated the mortality rate ratio, referred to here as the relative risk, together with 95% confidence intervals by Cox proportional hazards regression,³⁵ using PHREG software (SAS 6.12; SAS Institute Inc, Cary, NC). The analyses included a full 24-year follow-up as well as a follow-up restricted to the first 10 years.

In these analyses, both twins in a pair were included and treated as independent individuals. To ensure that confidence intervals were not erroneously narrow owing to similarities within pairs, we performed proportional hazards regression analyses with variance estimates adjusted for correlated outcomes.^{36–38} We accomplished this through the use of a SAS macro that stems from the same theoretical

background and yields the same results as the published Fortran program of Lin.³⁹

Synergistic effects were analyzed on the basis of odds ratios from logistic regression models, according to methods suggested by Rothman.⁴⁰ The factors showing a significant ($P<.05$) prevalence difference between ever- and never-unemployed individuals were considered to be of interest for an assessment of potential interaction with unemployment. Individuals unexposed to both unemployment and the other factor under study constituted the reference group. A synergy index was computed that indicated to what extent the presence of the factor influenced the effect of unemployment on mortality. A synergy index of 1 means no interaction, and a synergy index of 2 means an effect among those with combined exposures that is twice what would be expected from an additive effect of the 2 exposures. To calculate confidence intervals, we used methods of Hosmer and Lemeshow⁴¹ and computer programs described by Lundberg et al.⁴²

To control also for genetic and early childhood factors measured by the 1973 questionnaire, we analyzed mortality from all causes among 1067 twin pairs, 1 twin of whom had experienced unemployment while the other had not. We based the risk estimates (odds ratios) on conditional logistic regression for matched data using PHREG.

RESULTS

Among women subjects, elementary school, smoking, use of alcohol, use of tranquilizers, shift work, personality factors, illness, and low socioeconomic status showed at least a 10% higher prevalence among those who had experienced short-term unemployment or long-term unemployment compared with those who had no experience of unemployment (Table 1). Being divorced and use of sleeping pills was also more prevalent among those experiencing unemployment.

Unemployed men more often were unmarried, were childless, smoked, used tranquilizers, had introvert personalities, had long-lasting illnesses, and had low socioeconomic status compared with those without experience of unemployment. Furthermore, being divorced, using sleeping pills, and doing shift

TABLE 1—Prevalence (%) of Social, Behavioral, Health, and Personality Characteristics Among Women and Men, by Unemployment History: Sweden, 1973

Characteristic	Women					Men				
	History of Unemployment			Age-Adjusted Difference ^a (95% CI)		History of Unemployment			Age-Adjusted Difference ^a (95% CI)	
	Never	Short-Term ^b	Long-Term ^c	Short-Term	Long-Term	Never	Short-Term ^b	Long-Term ^c	Short-Term	Long-Term
Marital status										
Unmarried	27	41	38	-4 (-10, 1)	5 (-0.6, 10)	32	67	53	14 (6, 22)	15 (10, 21)
Divorced	5	6	10	... ^d	7 (3, 11)	3	3	6	... ^d	5 (1, 8)
Widow/widower	1	1	0	...	...	0	0	0	...	...
No children	38	56	40	-1 (-10, 8)	-6 (-11, 1)	41	71	62	11 (2, 19)	15 (10, 21)
Education: elementary school	41	35	54	-0.6 (-11, 9)	16 (9, 22)	45	41	41	2 (-7, 10)	-2 (0, -4)
Smoking status										
Current smoker	40	61	63	21 (11, 31)	22 (16, 29)	52	61	66	8 (-0.7, 17)	12 (6, 18)
Former smoker	13	14	12	-2 (-7, 3)	-0.4 (-5, 4)	14	10	13	0.1 (-7, 7)	-0.2 (-4, 4)
Alcohol consumption										
None	43	43	46	4 (-6, 13)	4 (-3, 12)	22	25	26	5 (-5, 14)	4 (-2, 10)
>250 g/mo	15	28	18	10 (0.5, 18)	2 (-4, 7)	46	52	50	4 (-7, 15)	4 (-3, 11)
Use of sedatives										
Sleeping pills occasionally/regularly	6	9	14	6 (-1, 14)	9 (4, 14)	3	6	10	5 (-1, 10)	9 (4, 13)
Sleeping pills regularly	1	3	7	2 (-2, 6)	6 (3, 10)	1	3	4	...	4 (1, 7)
Tranquilizers occasionally/regularly	14	16	27	7 (-2, 16)	17 (11, 23)	7	13	16	9 (2, 16)	11 (7, 16)
Tranquilizers regularly	4	8	10	7 (-0.3, 14)	8 (4, 13)	2	7	6	5 (1, 10)	6 (3, 10)
Stressful life situation	15	13	18	-1 (-8, 6)	5 (-0.2, 10)	19	17	20	3 (-5, 10)	2 (-3, 6)
Shift work	11	20	25	9 (0.4, 17)	14 (9, 20)	23	27	29	4 (-3, 11)	7 (1, 12)
Personality										
Extrovert	51	57	47	13 (5, 21)	-4 (-10, 3)	62	55	58	-16 (-24, -8)	-5 (-11, 1)
Unstable	26	47	48	19 (9, 29)	24 (17, 30)	15	30	28	14 (7, 22)	14 (9, 19)
Long-lasting/serious illness	15	19	19	12 (3, 21)	8 (2, 13)	15	22	20	11 (3, 19)	7 (2, 12)
Low socioeconomic status	77	87	90	9 (2, 16)	14 (10, 18)	70	85	82	11 (3, 18)	11 (7, 16)

Note. CI = confidence interval.

^aDifference in exposure prevalence between short-term or long-term unemployed and never unemployed.

^bUnemployed in 1973, lifetime unemployment less than 1 year.

^cEver unemployed, lifetime unemployment at least 1 year.

^dToo few cases for age-adjusted analyses.

work were more prevalent among the unemployed. The latter results were statistically significant, but the difference in prevalence was less than 10%.

Among women, external causes of death—suicide in particular—showed a strong association with unemployment, with an almost threefold relative risk for the 24-year follow-up period and a sixfold increase for the first 10 years of follow-up (Table 2). The increased rates among the unemployed remained after adjustment for possible confounding factors, although at a somewhat lower level. Disregarding specific causes, the ever unemployed showed an increased mortality rate based on

the 24-year follow-up, with identical but less precise estimates for the first 10 years.

For men, a strong association between unemployment and death from external undetermined cause was found, even after adjustment for potential confounding factors (Table 2). An association on a lower level was also found for all external causes. There tended to be an association between malignant neoplasms and unemployment, which was weakened and still imprecise when potential confounders were controlled for. Total mortality over the 2 follow-up periods was higher among the ever unemployed; adjusting for potential confounding factors somewhat lowered the estimates.

In analyses in which the confidence intervals were adjusted for correlated outcomes, the confidence intervals of the mortality rate ratios were in general identical to those of the unadjusted analyses, showing little influence from correlation within twin pairs (data not shown).

For women, a synergy index of 7.0 was found for the joint presence of unemployment and use of sleeping pills (Table 3), indicating a mortality effect 7 times higher than expected from additivity. For women in the exposed group, use of tranquilizers, extrovert personality, and unstable personality combined with unemployment showed a synergistic relation to mortality, although the statistical precision

TABLE 2—Relative Risks for Specific Causes of Death and Total Mortality Among Women and Men, by Exposure to Unemployment: Sweden, 1973

Cause of Death (ICD-8 Codes)	RR (95% CI) at 24-y Follow-Up				RR (95% CI) at 10-y Follow-Up			
	Total No. of Deaths	No. of Deaths Among Those Exposed to Unemployment	Age-Adjusted	Full Model ^a	Total No. of Deaths	No. of Deaths Among Those Exposed to Unemployment	Age-Adjusted	Full Model ^a
Women								
Total mortality	399	42	1.7 (1.2, 2.4)	1.4 (1.0, 1.9)	73	8	1.7 (0.8, 3.7)	1.4 (0.7, 3.0)
Malignant neoplasms (140–209)	208	16	1.3 (0.8, 2.1)	1.1 (0.7, 1.9)	37	1	0.4 (0.1, 3.2)	0.4 (0.1, 2.8)
Malignant neoplasm of trachea, bronchus, or lung (162)	22	1	0.9 (0.1, 6.8)	0.6 (0.1, 4.2)	2	0	...	...
Diseases of the circulatory system (390–458)	68	6	1.6 (0.7, 3.7)	1.3 (0.5, 3.0)	11	0	...	...
Ischemic heart diseases (410–414)	31	3	1.8 (0.5, 5.9)	1.3 (0.4, 4.5)	3	3	...	...
Injuries, poisoning, other external causes (E800–E999)	50	11	2.8 (1.4, 5.7)	2.0 (1.0, 4.1)	18	6	6.2 (2.2, 17.5)	4.2 (1.5, 12.3)
Suicide (E950–E959)	30	8	4.1 (1.7, 9.5)	2.7 (1.2, 6.5)	13	4	5.3 (1.6, 18.0)	3.7 (1.0, 13.0)
External undetermined cause (E980–E989) ^b	4	2	15.8 (1.3, 196.4)	10.7 (0.9, 133.0)	2	1	...	...
Other diagnoses	73	9	2.0 (1.0, 4.0)	1.3 (0.6, 2.7)	7	1	1.8 (0.2, 16.1)	1.6 (0.2, 13.8)
Alcoholism, cirrhosis of liver, pancreatitis (303, 571, 577)	10	1	1.3 (0.2, 11.0)	1.0 (0.1, 8.1)	2	1	14.7 (0.9, 252.9)	10.4 (0.6, 185.2)
Men								
Total mortality	792	97	1.6 (1.3, 1.9)	1.3 (1.0, 1.6)	208	32	1.9 (1.3, 2.8)	1.5 (1.0, 2.2)
Malignant neoplasms (140–209)	224	26	1.6 (1.0, 2.4)	1.4 (0.9, 2.1)	47	8	2.5 (1.1, 5.3)	2.1 (0.9, 4.6)
Malignant neoplasm of trachea, bronchus, or lung (162)	38	5	1.7 (0.7, 4.5)	1.5 (0.6, 4.1)	5	1	3.1 (0.3, 29.0)	2.9 (0.3, 28.0)
Diseases of the circulatory system (390–458)	237	23	1.4 (0.9, 2.2)	1.2 (0.8, 1.8)	40	5	1.9 (0.7, 5.0)	1.4 (0.5, 3.8)
Ischemic heart diseases (410–414)	161	15	1.4 (0.8, 2.4)	1.2 (0.7, 2.1)	27	2	1.1 (0.3, 4.7)	0.8 (0.2, 3.6)
Injuries, poisoning, other external causes (E800–E999)	200	35	1.8 (1.2, 2.6)	1.5 (1.0, 2.2)	91	16	1.8 (1.0, 3.1)	1.5 (0.8, 2.6)
Suicide (E950–E959)	91	12	1.3 (0.7, 2.4)	1.0 (0.6, 2.0)	38	4	1.1 (0.4, 3.2)	0.9 (0.3, 2.6)
Undetermined cause of death (E980–E989) ^b	23	10	7.7 (3.3, 17.9)	5.8 (2.4, 14.0)	8	4	8.6 (2.1, 36.2)	5.8 (1.3, 25.4)
Other diagnoses	131	13	1.2 (0.7, 2.2)	0.9 (0.5, 1.5)	30	3	1.4 (0.4, 4.7)	0.9 (0.3, 3.2)
Alcoholism, cirrhosis of liver, pancreatitis (303, 571, 577)	40	6	2.0 (0.8, 4.8)	1.3 (0.5, 3.3)	14	2	2.2 (0.5, 10.2)	1.6 (0.3, 7.5)

Note. RR = relative risk; CI = confidence interval; ICD-8 = *International Classification of Diseases, Eighth Revision*.³³

^aFor women, relative risk is adjusted for age, marital status, smoking status, alcohol consumption, use of tranquilizers, extroverted personality, and long-lasting/serious illness. For men, relative risk is adjusted for age, marital status, smoking status, alcohol consumption, use of sleeping pills, unstable personality, and long-lasting/serious illness.

^bUncertainty whether injury is accidental or intentional.

was weak owing to small numbers. For men, elementary school education, use of sleeping pills, and long-lasting or serious illness combined with unemployment were associated with a mortality rate ratio that exceeded expectancy based on additivity.

In the mortality analysis within twin pairs, where 1 twin had experienced unemployment while the other had not, the estimated relative risk of death for unemployed was 1.5 (95% confidence interval [CI]=0.7, 3.1) among women. A corresponding estimate of 1.4 (95% CI=1.0, 2.0) was found for men. Controlling for social, behavioral, health, and personality factors from the 1973 questionnaire lowered the relative risks marginally, to 1.4 (CI=0.6, 3.4) and 1.3 (CI=0.9, 1.9) for women and men, respectively.

DISCUSSION

The results from this study suggest that unemployment is associated with an increased risk of early death even after adjustment for several potential confounding factors, including socioeconomic status, lifestyle factors, and genetic and early childhood factors. In particular, unemployment was associated with increased mortality from suicide and external undetermined cause. Among unemployed men, an increased risk of death from malignant neoplasms was also suggested. Furthermore, the results indicate that the risk of early mortality following unemployment may be strengthened by social, health, and personality factors.

One way to assess unemployment's public health impact is to estimate the attributable frac-

tion (the proportion of deaths that would be eliminated if mortality among the unemployed were reduced to that among the employed). The estimate depends on the strength of the association between exposure and outcome and also on the prevalence of the exposure. On the basis of our study results (24-year follow-up), and keeping the statistical imprecision in mind, the attributable fraction for suicides was 20% among women. For men, the attributable fraction for external undetermined cause was 38%.

Unemployment

Information about current or previous unemployment was collected at baseline in 1973 only. The number of unemployment episodes and the duration of each episode was not recorded. "Ever unemployed" may therefore

TABLE 3—Interactions Between Unemployment and Risk Indicators of Mortality for Women and Men: Sweden, 1973

Risk Indicator	n ^a	Ever Unemployed, Without Risk Indicator, ^b OR (95% CI)	Never Unemployed, With Risk Indicator, ^b OR (95% CI)	Ever Unemployed, With Risk Indicator, ^b OR (95% CI)	Synergy Index ^c (95% CI)
Women					
Unmarried, divorced, widow	477	1.6 (1.0, 2.5)	1.4 (1.1, 1.7)	2.5 (1.6, 3.9)	1.5 (0.5, 4.4)
No children	526	2.1 (1.4, 3.1)	1.2 (0.9, 1.5)	1.6 (0.9, 2.7)	0.5 (0.1, 2.3)
Elementary school	381	1.9 (1.2, 3.0)	1.1 (0.9, 1.4)	1.8 (1.1, 2.9)	0.8 (0.2, 2.7)
Smoker	492	1.6 (0.9, 2.7)	1.7 (1.4, 2.1)	2.9 (1.9, 4.3)	1.5 (0.6, 3.7)
Alcohol consumption >250 g	123	2.0 (1.4, 2.8)	1.4 (1.1, 1.9)	1.2 (0.4, 3.4)	0.2 (0.0, 40.1)
Use of sleeping pills	70	1.4 (1.0, 2.1)	1.4 (1.0, 2.0)	6.6 (1.1, 12.5)	7.0 (2.2, 22.5)
Use of tranquilizers	175	1.4 (0.9, 2.1)	1.5 (1.2, 2.0)	3.5 (2.1, 5.7)	2.7 (1.0, 7.6)
Shift work	176	1.9 (1.3, 2.7)	1.3 (0.9, 1.7)	1.5 (0.7, 3.2)	0.4 (0.0, 4.8)
Extravert personality	445	1.2 (0.7, 2.1)	1.3 (1.0, 1.5)	2.8 (1.8, 4.1)	3.9 (0.7, 22.7)
Unstable personality	405	1.1 (0.7, 2.0)	1.4 (1.1, 1.7)	3.0 (2.0, 4.5)	3.8 (0.9, 15.6)
Long-lasting or serious illness	154	1.6 (1.1, 2.4)	1.8 (1.5, 2.4)	3.4 (2.0, 5.9)	1.6 (0.7, 4.0)
Blue-collar worker or lower white-collar worker	779	1.5 (0.5, 4.3)	1.1 (0.9, 1.5)	2.0 (1.4, 3.0)	1.5 (0.1, 16.5)
Men					
Unmarried, divorced, widower	704	1.8 (1.3, 2.4)	1.9 (1.6, 2.3)	2.1 (1.5, 2.9)	0.6 (0.3, 1.3)
No children	788	1.9 (1.4, 2.6)	1.5 (1.2, 1.7)	1.6 (1.1, 2.3)	0.4 (0.2, 1.1)
Elementary school	543	1.1 (0.8, 1.6)	1.2 (1.0, 1.4)	2.3 (1.8, 3.1)	4.1 (1.0, 16.7)
Smoker	800	1.5 (1.0, 2.3)	1.9 (1.6, 2.2)	2.7 (2.0, 3.6)	1.2 (0.7, 2.2)
Alcohol consumption >250g	530	1.4 (1.0, 1.9)	1.3 (1.2, 1.6)	2.3 (1.7, 3.1)	1.7 (0.8, 3.9)
Use of sleeping pills	60	1.5 (1.1, 1.8)	1.8 (1.2, 2.5)	3.5 (1.9, 6.8)	2.1 (0.7, 6.1)
Use of tranquilizers	130	1.5 (1.1, 1.9)	1.5 (1.1, 1.9)	2.6 (1.6, 4.2)	1.7 (0.6, 4.5)
Shift work	395	1.5 (1.1, 1.9)	1.1 (0.9, 1.3)	1.8 (1.3, 2.6)	1.4 (0.5, 4.1)
Extravert personality	783	1.8 (1.3, 2.5)	1.1 (0.9, 1.3)	1.5 (1.1, 2.0)	0.5 (0.2, 1.6)
Unstable personality	350	1.3 (1.0, 1.8)	1.5 (1.3, 1.9)	2.6 (1.8, 3.6)	1.8 (0.8, 3.8)
Long-lasting or serious illness	233	1.4 (1.0, 1.8)	1.4 (1.2, 1.7)	2.7 (1.9, 4.0)	2.2 (1.0, 5.0)
Blue-collar worker or lower white-collar worker	1085	1.8 (1.1, 3.0)	1.3 (1.1, 1.5)	1.8 (1.4, 2.3)	0.7 (0.3, 1.9)

^aNumber of unemployed also exposed to the risk indicator.

^bOdds ratio (OR) and 95% confidence interval (95% CI) are adjusted for age. The reference group (OR = 1) refers to cases and referents among the individuals unexposed to both unemployment and the risk indicator under study.

^cSynergy index: 1.0 = no interaction, 2.0 = an effect among those with combined exposure twice what would be expected from an additive effect of the 2 exposures, etc.

apply to 1 or several occasions of different length, remote from or close in time to the start of follow-up. In addition, we had no information on unemployment occurring after 1973. Exposed individuals could repeatedly be unemployed during follow-up. This does not lead to misclassification of the exposure because we did not take different levels of exposure into account—the exposure we analyzed was “ever unemployed.” Individuals classified as never unemployed as of 1973 could encounter unemployment later on and therefore be misclassified. This limitation would lead to underestimated risk estimates if those who became unemployed after 1973 had the same mortality pattern as those reported as ever unemployed

as of 1973. If the individuals who became unemployed after 1973 had a lower death rate than those earlier classified as unemployed, then the reported estimates could be biased upward; however, we have no reason to believe this to be the case. On the other hand, it is uncertain to what extent the results obtained are valid for more recent time periods, when worker groups other than those of the present study are facing unemployment.

We used a 24-year follow-up as well as a shorter period: the first 10 years of the follow-up (1973–1982). For several of the cause-specific diagnoses, higher mortality rate ratios were found for the 10-year period than for the longer follow-up. This finding could

owe partly to increased misclassification of unexposed individuals over time. It could also be that unemployment entails an increased risk of death (during a limited time period) that gradually fades away. The results suggest that unemployment may have an impact on mortality, not only in a short-term but also in a long-term perspective.

Selection and Pathway

In accordance with other studies,^{12,21,25} several factors related to mortality were significantly more prevalent among the unemployed than among the never unemployed (Table 1). These characteristics could either lead to or be a consequence of unemployment. The associa-

tion between unemployment and mortality may therefore partly be a result of selection mechanisms, in that individuals with certain risk indicators are more likely to become unemployed than those without the risk indicators in question. However, unemployment may also contribute to the development of these risk indicators and, in turn, to poor health. The cross-sectional data did not permit a clear determination of the timing between risk indicators and unemployment in this study.

Adjustment for risk indicators that constitute links in the causal chain between an exposure and an outcome may inaccurately reduce an association and mask an actual effect or part of the effect attributable to the exposure. Low education, personality factors, and low socioeconomic status are comparatively stable over time and may in general precede unemployment. Shift work should also mainly (but not exclusively) precede unemployment, assuming that occupational mobility is comparatively low in terms of this occupational characteristic. Furthermore, we see no reason why unemployment should increase the probability of holding a job with shift work. Serious or long-lasting illness could also be a precursor, since subjects with poor health may be more likely to lose their job. Divorce may to some extent be a consequence of unemployment, and smoking and use of sleeping pills and tranquilizers could be a coping behavior owing to psychological stress caused by unemployment. In the extended multivariate analyses, the relative risks were often attenuated compared with the age-adjusted relative risks, and this attenuation may be partly attributable to unwarranted adjustment for factors in the causal chain.

A major advantage of our study was that it controlled for confounding owing to genetic and early social and environmental conditions by analyzing unemployment among discordant twin pairs. In general, twins have early social and environmental conditions in common; in addition, monozygotic twins are genetically identical and dizygotic twins have half of their genes in common. The twin analyses showed an increased risk of death for the exposed twin compared with his or her twin sibling. The confidence intervals were wide owing to a rather small number of deaths. Nevertheless, it is notable that this analysis, which controlled for many predisposing life conditions, yielded risk

estimates comparable to the analyses based on the full cohort.

Specific Causes of Death

We found an association between unemployment and external causes of death for both women and men. This finding is consistent with those of other studies,^{9,12,13} although few of these included women.⁹ Suicide was clearly associated with unemployment among women, but not among men. On the other hand, men who experienced unemployment had an increased risk of death by external undetermined cause. This finding raises the possibility that suicide is less likely to be identified among men than among women. In some studies reporting an association between suicide and unemployment among men, deaths by external undetermined cause and suicides were combined.^{19,20}

The results indicate that unemployment has an important impact on mental health. Unemployment may cause a deterioration of economic situation, downgrading of social status, broken social relations, changed risk behaviors, impaired psychological well-being, and depression, consequences that may develop into severe illness.^{1-4,6-8,17,18,25}

Several studies have reported an increased risk of mortality from cardiovascular disease with unemployment.^{1,21-23} Our study showed no such increased risk, which is in accordance with another recent Swedish study.¹⁶ It has been suggested that inability to control for behavioral and medical parameters before and after unemployment, and a too short follow-up period, contribute to difficulties in showing a possible relationship between unemployment and cardiovascular diseases.¹⁵ Our results do not support this view but rather indicate that an association between unemployment and death from cardiovascular diseases observed in some studies may be confounded by other risk factors.

Other studies have pointed out that the excess cancer mortality among the unemployed owes mainly to an increased risk of lung cancer.^{2,11,12,21,24} Our results for men are consistent with this observation, although they lack precision owing to small numbers. As in our study, other studies have reported a higher prevalence of smokers among the unemployed, and they have shown that smoking habits stay quite stable during unemployment.^{11,21} In our study,

the prevalence of smoking among short-term and long-term unemployed women was similar, and there was only a slight difference among men, suggesting that, to some extent, smoking may be a precursor of unemployment. It is possible that smokers have a greater risk of losing their job either because of smoking or because of other factors related to smoking.

An increased mortality from alcohol-related diseases among the unemployed was reported by Martikainen.¹² Our data were consistent with such an association among men, although the results were based on few deaths and the risk estimate decreased in the full model. Morris et al. reported a higher prevalence of alcohol use among the unemployed.²¹ In our study, increased alcohol use among the unemployed was seen only among women who experienced short-term unemployment in 1973.

Interaction

As far as we know, no other study has focused on the question of interaction between unemployment and the characteristics of the individual relative to early death. It has been suggested previously that buffering effects from social support, for example, could reduce the negative effects of the stress of losing a job.^{4,7,8,10} Our results indicate that modifying the effects of individual characteristics could strengthen the association between unemployment and mortality. For men, but not for women, low education seemed to enhance the association between unemployment and mortality. It is possible that unemployment means greater strain in economic and social terms, particularly for men with low education.

Furthermore, our results suggest that use of sleeping pills or tranquilizers may enhance the risk of early death among individuals who experience unemployment, particularly women. Use of these drugs may be caused by unemployment, and this type of coping may reflect a particularly strong reaction. Apart from the availability of drugs, which may be the direct cause of death, the interaction could also signify that women using these drugs are more vulnerable owing to different psychosocial problems or mental diseases, and that unemployment may augment a prevailing difficult situation. In addition, the synergistic effects indicated for unstable personality traits and for serious or long-lasting illness may indicate that

unemployment among individuals already burdened by psychological disorders, somatic illness, or both may overwhelm the individual.

CONCLUSIONS

Unemployment is associated with an increased risk of early death, especially from suicide and external undetermined cause. Our results suggest that characteristics of the individual prior to unemployment cannot explain this increased risk. They further indicate that the association between unemployment and mortality may be strengthened by social factors, personality characteristics, and health-related factors. An increased risk of early mortality related to unemployment should be recognized. ■

About the Authors

Margaretha Voss is with the Department of Clinical Neuroscience and the Institute of Environmental Medicine, Karolinska Institutet, and the National Institute for Working Life, Stockholm, Sweden. Lotta Nylén is with the National Institute for Working Life, Stockholm, Sweden. Birgitta Floderus is with the Institute of Environmental Medicine and the Department of Public Health Sciences, Karolinska Institutet, and the National Institute for Working Life, Stockholm, Sweden. Finn Diderichsen is with the Department of Public Health Sciences, Karolinska Institutet, Stockholm, Sweden, and the Institute of Public Health, University of Copenhagen, Copenhagen, Denmark. Paul D. Terry is with the Department of Medical Epidemiology and Biostatistics, Karolinska Institutet, Stockholm, Sweden.

Requests for reprints should be sent to Margaretha Voss, PhD, MPH, Department of Clinical Neuroscience, Section of Personal Injury Prevention, Karolinska Institutet, Box 12718, SE-112 94 Stockholm, Sweden (e-mail: margaretha.voss@cns.ki.se).

This article was accepted September 18, 2003.

Contributors

M. Voss and L. Nylén contributed substantially in the conceptualization and design of the study and had main responsibility for the analyses and the reporting. B. Floderus initiated the study and supervised all aspects of its implementation. F. Diderichsen contributed to conceptualization of ideas. P.D. Terry assisted with the analyses. All authors helped to interpret the findings and reviewed drafts of the article.

Acknowledgments

Support for this study was provided by the Karolinska Institutet and the National Institute for Working Life, Stockholm, Sweden.

Human Participant Protection

Participation in the study was optional for all members of the Swedish Twin Registry, and all subjects received general information about the general purpose of the registry. The Ethical Committee at Karolinska Institutet approved the principles for use of the Twin Registry and also this particular study.

References

1. Jin RL, Shah CP, Svoboda TJ. The impact of unemployment on health: a review of the evidence. *CMAJ*. 1995;153(5):529–540.
2. Wilson SH, Walker GM. Unemployment and health: a review. *Public Health*. 1993;107:153–162.
3. Jahoda M. The impact of unemployment in the 1930s and the 1970s. *Bull Br Psychol Soc*. 1979;32:309–314.
4. Hammarström A. Health consequences of youth unemployment—review from a gender perspective. *Soc Sci Med*. 1994;38(5):699–709.
5. Platt S. Unemployment and suicidal behaviour: a review of the literature. *Soc Sci Med*. 1984;19(2):93–115.
6. Mathers CD, Schofield DJ. The health consequences of unemployment: the evidence. *Med J Aust*. 1998;168:178–182.
7. Dooley D, Fielding J, Levi L. Health and unemployment. *Annu Rev Public Health*. 1996;17:449–465.
8. Kasl SV, Jones BA. The impact of job loss and retirement on health. In: Berkman LF, Kawachi I, eds. *Social Epidemiology*. New York, NY: Oxford University Press; 2000:118–136.
9. Iversen L, Andersen O, Andersen PK, Christoffersen K, Keiding N. Unemployment and mortality in Denmark, 1970–80. *BMJ*. 1987;295:879–884.
10. Levi L. Psychosocial environmental factors and psychosocial mediated effects of physical environmental factors. *Scand J Work Environ Health*. 1997;23(suppl 3):47–52.
11. Lynge E. Unemployment and cancer: a literature review. *IARC Sci Publ*. 1997;138:343–351.
12. Martikainen PT. Unemployment and mortality among Finnish men, 1981–5. *BMJ*. 1990;301:407–411.
13. Moser KA, Fox AJ, Jones DR. Unemployment and mortality in the OPCS longitudinal study. *Lancet*. 1984;2:1324–1329.
14. Stefansson C-G. Long-term unemployment and mortality in Sweden, 1980–1986. *Soc Sci Med*. 1991;32(4):419–423.
15. Weber A, Lehnert G. Unemployment and cardiovascular diseases: a causal relationship? *Int Arch Occup Environ Health*. 1997;70(3):153–160.
16. Gerdtham U-G, Johannesson M. A note on the effect of unemployment on mortality. *J Health Econ*. 2002;22:505–518.
17. Björklund A, Eriksson T. Unemployment and mental health: evidence from research in the Nordic countries. *Scand J Soc Welfare*. 1998;7:219–235.
18. Nordenmark M. *Unemployment, Employment Commitment and Well-Being: The Psychosocial Meaning of (Un)Employment Among Women and Men* [dissertation]. Umeå, Sweden: Department of Sociology, Umeå University; 1999.
19. Kposowa AJ. Unemployment and suicide: a cohort analysis of social factors predicting suicide in the US National Longitudinal Mortality Study. *Psychol Med*. 2001;31(1):127–138.
20. Lewis G, Sloggett A. Suicide, deprivation and unemployment: record linkage study. *BMJ*. 1998;317:1283–1286.
21. Morris JK, Cook DG, Shaper AG. Loss of employment and mortality. *BMJ*. 1994;308:1135–1139.
22. Brenner MH. Heart disease mortality and economic changes, including unemployment, in Western Germany 1951–1989. *Acta Physiol Scand Suppl*. 1997;640:149–152.
23. Forbes JF, McGregor A. Male unemployment and cause-specific mortality in postwar Scotland. *Int J Health Serv*. 1987;17(2):233–240.
24. Lynge E, Andersen O. Unemployment and cancer in Denmark, 1970–1975 and 1986–1990. *IARC Sci Publ*. 1997;138:353–359.
25. Janlert U. Unemployment as a disease and diseases of the unemployed. *Scand J Work Environ Health*. 1997;23(suppl 3):79–83.
26. Martikainen PT, Valkonen T. Excess mortality of unemployed men and women during a period of rapidly increasing unemployment. *Lancet*. 1996;348:909–912.
27. Bartley M, Owen C. Relation between socioeconomic status, employment, and health during economic change, 1973–93. *BMJ*. 1996;313:445–449.
28. Martikainen PT, Valkonen T. The effects of differential unemployment rate increases of occupation groups on changes in mortality. *Am J Public Health*. 1998;88(12):1859–1861.
29. Nylén L, Voss M, Floderus B. Mortality among women and men relative to unemployment, part time work, overtime work, and extra work: a study based on data from the Swedish twin registry. *Occup Environ Med*. 2001;58(1):52–57.
30. Medlund P, Cederlöf R, Floderus B, Friberg L, Sörensen S. *A New Swedish Twin Registry*. Stockholm, Sweden: Karolinska Institutet; 1976.
31. Floderus B. *Psycho-Social Factors in Relation to Coronary Heart Disease and Associated Risk Factors* [dissertation]. Stockholm, Sweden: Department of Environmental Hygiene, Karolinska Institutet. *Nordisk Hygienisk Tidskrift*. 1974(suppl 6):1–148.
32. Floderus-Myrhed B, Pedersen N, Rasmuson I. Assessment of heritability for personality, based on a short-form of the Eysenck Personality Inventory: a study of 12,898 twin pairs. *Behav Genetics*. 1980;10(2):153–162.
33. *International Classification of Diseases, Eighth Revision*. Geneva, Switzerland: World Health Organization; 1965.
34. *International Classification of Diseases, Ninth Revision*. Geneva, Switzerland: World Health Organization; 1980.
35. Clayton D, Hills M. *Statistical Models in Epidemiology*. New York, NY: Oxford University Press; 1993.
36. Lin DY. Cox regression analysis of multivariate failure time data: the marginal approach. *Stat Med*. 1994;13(21):2233–2247.
37. Wei LJ, Lin DY, Weissfeld L. Regression analysis of multivariate incomplete failure time data by modeling marginal distributions. *J Am Stat Assoc*. 1989;84(408):1065–1073.
38. White H. Maximum likelihood estimation of misspecified models. *Econometrica*. 1982;50(1):1–25.
39. Lin DY. MULCOX2: a general computer program for the Cox regression analysis of multivariate failure time data. *Comput Methods Programs Biomed*. 1993;40(4):279–293.
40. Rothman KJ. *Modern Epidemiology*. Boston, Mass: Little, Brown and Company; 1986.
41. Hosmer DW, Lemeshow S. Confidence interval estimation of interaction. *Epidemiology*. 1992;3(5):452–456.
42. Lundberg M, Fredlund P, Hallqvist J, Diderichsen F. A SAS program calculating three measures of interaction with confidence intervals. *Epidemiology*. 1996;7(6):655–656.